

THE CLAIMS

What is claimed is:

1. A method for forming golf equipment, or a portion thereof, which comprises:
 - 5 providing a first reactable component comprising an isocyanate-containing compound; and a second reactable component comprising at least one of a polyol, polyamine, or epoxy-containing compound; and
 - combining the reactable components together to form a reactive mixture; and
 - injecting the reactive mixture into a cavity or mold having a desired shape
 - 10 within about 60 seconds after the combining to avoid substantial gelation or solidification so as to provide at least a portion of the golf equipment,
 - wherein the isocyanate-containing compound comprises ethylene diisocyanate, propylene-1,2-diisocyanate, tetramethylene-1,4-diisocyanate, 1,6-hexamethylene diisocyanate, 2,2,4-trimethylhexamethylene diisocyanate, dodecane-
 - 15 1,12-diisocyanate, 2,2,4-trimethylhexamethylene diisocyanate, 4,4'-dicyclohexylmethane diisocyanate, 2,4,4-trimethylene diisocyanate, cyclobutane-1,3-diisocyanate, cyclohexane-1,3-diisocyanate, cyclohexane-1,4-diisocyanate, methyl cyclohexylene diisocyanate, 1-isocyanato-3,3,5-trimethyl-5-isocyanatomethyl cyclohexane, isophorone diisocyanate, 4,4'-diphenylmethane diisocyanate, polymeric 4,4'-diphenylmethane diisocyanate,
 - 20 carbodiimide-modified liquid 4,4'-diphenylmethane diisocyanate, p-phenylene diisocyanate, m-phenylene diisocyanate, toluene diisocyanate, 3,3'-dimethyl-4,4'-biphenylene diisocyanate, naphthalene diisocyanate, xylylene diisocyanate, tetracene diisocyanate, naphthalene diisocyanate, anthracene diisocyanate, the isocyanurate of toluene diisocyanate, the isocyanurate of a hexamethylene diisocyanate, the uretdione of toluene diisocyanate, the
 - 25 uretdione of 1,6-hexamethylene diisocyanate, or a mixture thereof.
2. The method of claim 1, wherein the isocyanate-containing component comprises a polyisocyanate or a prepolymer or quasi-prepolymer containing the reaction product of a polyol, polyamine, or epoxy-containing compound with at least one
- 30 polyisocyanate.
3. The method of claim 1, wherein the isocyanate-containing component contains greater than about 14% isocyanate by weight, compared to the total weight of the isocyanate-containing component.

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4. The method of claim 1, wherein the isocyanate-containing compound comprises an aliphatic polyisocyanate, 4,4'-diphenylmethane diisocyanate, *m*-phenylene diisocyanate, *p*-phenylene diisocyanate, toluene diisocyanate, or a mixture thereof.

5 5. The method of claim 1, wherein the golf equipment comprises a golf ball, or a portion thereof.

6. The method of claim 5, wherein the golf ball has at least one of a compression from about 50 to 120 or a coefficient of restitution of greater than about 0.7.

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7. The method of claim 5, wherein the golf ball comprises a solid or fluid-filled center, optionally at least one intermediate layer disposed about the center, and at least one cover layer disposed about the center and the optional intermediate layer, if present.

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8. The method of claim 7, wherein the cover layer has a first material hardness and the layer disposed immediately inside the cover layer has a second material hardness, and wherein the first material hardness is no less than the second material hardness.

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9. The method of claim 7, wherein the cover layer of the golf ball has a first material hardness and the layer disposed immediately inside the cover layer has a second material hardness, and wherein the first material hardness is at least 55 Shore D or the second material hardness is up to 55 Shore D.

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10. The method of claim 7, wherein the cover layer has a first material hardness and the layer disposed immediately inside the cover layer has a second material hardness, and wherein the second material hardness is no less than the first material hardness.

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11. The method of claim 7, wherein the cover layer of the golf ball has a first material hardness and the layer disposed immediately inside the cover layer has a second material hardness, and wherein the second material hardness is at least 55 Shore D or the first material hardness is up to 55 Shore D.

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12. The method of claim 5, wherein the core of the golf ball has an outer diameter from about 1.55 inches to 1.67 inches.

13. The method of claim 5, wherein the injecting results in the formation of golf equipment, or a portion thereof, which has a thickness less than about 0.065 inches.

14. The method of claim 5, wherein the second reactable component comprises a first isocyanate-reactive compound having a molecular weight less than about 400 g/mol, and a second isocyanate-reactive compound having a number average molecular weight of not less than about 400 g/mol.

15. The method of claim 14, wherein the second isocyanate-reactive compound comprises a polyether polyol, a hydroxy-terminated polybutadiene, a polyester polyol, a polycarbonate polyol, or a copolymer or a mixture thereof.

16. The method of claim 15, wherein the polyether polyol comprises poly(tetramethylene oxide) glycol, poly(ethylene oxide) glycol, poly(propylene oxide) glycol, poly(oxyethylene-oxypropylene) glycol copolymers, or mixtures or copolymers thereof; or wherein the polyester polyol comprises polyethylene adipate glycol, polypropylene adipate glycol, polybutylene adipate glycol, poly(ethylene adipate-propylene adipate) glycol, poly(hexamethylene adipate) glycol, a polycaprolactone polyol, or mixtures or copolymers thereof; or wherein the polycarbonate polyol comprises poly(phthalate carbonate) glycol, poly(hexamethylene carbonate) glycol, polycarbonate glycols containing bisphenol A, or mixtures or copolymers thereof.

17. The method of claim 5, wherein the gelation or solidification time of the reactive mixture is from about 0.25 seconds to 30 seconds.

18. The method of claim 5, wherein the gelation or solidification time of the reactive mixture is from about 1 second to 5 seconds.

19. The method of claim 5, wherein the viscosity of each of the reactable components, or mixture thereof, is not more than about 20,000 cPs at ambient temperature or at a temperature at which the reactable components are combined.

20. The method of claim 5, wherein the viscosity of each of the reactable components, or mixture thereof, is from about 25 cPs to 10,000 cPs at a temperature at which the reactable components are combined.
- 5 21. The method of claim 5, wherein the viscosity index of two of the reactable components is from about 1000 to 1 at ambient temperature or at a temperature at which the reactable components are combined.
- 10 22. The method of claim 5, wherein the golf ball, or a portion thereof, has an MVTR of less than about 500 (g•mil)/(100in²•day).
23. The method of claim 5, which further comprises adding from about 0.1% to 50% by weight of a filler material.
- 15 24. The method of claim 5, which further comprises adding at least one catalyst to facilitate the reaction between the at least two reactable components when they are combined.
- 20 25. The method of claim 24, wherein the catalyst is present in an amount from about 0.001% to 3% by weight and comprises a metal catalyst, an amine catalyst, an organic acid, a delayed catalyst, or a combination thereof.
- 25 26. The method of claim 5, wherein the isocyanate-containing component comprises a polyisocyanate or a prepolymer or quasi-prepolymer containing the reaction product of a polyol, polyamine, or epoxy-containing compound with at least one polyisocyanate.
27. The method of claim 5, wherein the isocyanate-containing component contains greater than about 14% isocyanate by weight, compared to the total weight of the isocyanate-containing component.
- 30 28. The method of claim 5, wherein the isocyanate-containing compound comprises an aliphatic polyisocyanate, 4,4'-diphenylmethane diisocyanate, *m*-phenylene diisocyanate, *p*-phenylene diisocyanate, toluene diisocyanate, or a mixture thereof.
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29. A method for forming golf equipment, or a portion thereof, which comprises:

providing a first reactable component comprising a low free isocyanate monomer composition; and a second reactable component comprising at least one polyol, polyamine, or epoxy-containing compound;

combining the reactable components together to form a reactive mixture; and injecting the reactive mixture into a cavity or mold having a desired shape within about 60 seconds after the combining to avoid substantial gelation or solidification so as to provide at least a portion of the golf equipment.

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30. A method for forming golf equipment, or a portion thereof, which comprises:

providing a first reactable component comprising an isocyanate-containing compound; and a second reactable component comprising at least one polyol, polyamine, or epoxy-containing compound;

combining the reactable components together to form a reactive mixture; and injecting the reactive mixture into a cavity or mold having a desired shape within about 60 seconds after the combining to form a polymer or copolymer containing a hard segment and a soft segment and to avoid substantial gelation or solidification so as to provide at least a portion of the golf equipment,

wherein the hard segment is present in an amount from about 5% to 60%, based on the total weight of the polymer, or wherein the soft segment is present in an amount from about 40% to 95%, based on the total weight of the polymer.

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31. A method for forming golf equipment, or a portion thereof, which comprises:

providing a first reactable component comprising an isocyanate-containing compound, and a second reactable component comprising at least one polyol, polyamine, or epoxy-containing compound, wherein each reactable component has a viscosity not more than about 5,000 cPs at a temperature of about 150°F;

combining the reactable components together to form a reactive mixture; and injecting the reactive mixture into a cavity or mold having a desired shape within about 60 seconds after the combining to avoid substantial gelation or solidification so as to provide at least a portion of the golf equipment.

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32. A method for forming golf equipment, or a portion thereof, which comprises:

providing a first reactable component comprising an isocyanate-containing compound, and a second reactable component comprising at least one polyol, polyamine, or epoxy-containing compound;
combining the reactable components together to form a reactive mixture; and
injecting the reactive mixture at an injection pressure of not more than about 2,500 psi into a cavity or mold having a desired shape within about 60 seconds after the combining to avoid substantial gelation or solidification so as to provide at least a portion of the golf equipment.

33. A method for forming golf equipment, or a portion thereof, which comprises:

providing at least two sets of precursor components that can be reacted to form at least two different polymers of an interpenetrating polymer network, at least one polymer being crosslinked;
combining the sets of precursor components together to form a reactive mixture; and
injecting the reactive mixture into a cavity or mold having a desired shape within about 60 seconds after the combining to avoid substantial polymerization, gelation, or solidification, so as to provide at least a portion of the golf equipment.

34. The method of claim 33, wherein the at least two sets of precursor components comprise a first reactable component which comprises an isocyanate-containing compound, and a second reactable component, which comprises an isocyanate-reactive compound.

35. A method for forming golf equipment, or a portion thereof, which comprises:

providing at least two reactable components that, when combined, can form a foamed polymeric material;
combining the reactable components together to form a reactive mixture; and
injecting the reactive mixture into a cavity or mold having a desired shape within about 60 seconds after the combining to avoid substantial gelation or solidification and such that the reactive mixture forms a foamed polymeric material, so as to provide at least a portion of the golf equipment.

36. The method of claim 35, wherein the foamed polymeric material comprises an open-cell, closed-cell, or microcellular foam, or a combination thereof.

37. The method of claim 35, wherein the foamed polymeric material has
5 a specific gravity of not more than about 1.

38. Golf equipment prepared by the process of claim 1.

39. A multi-layer golf ball prepared by the process of claim 5.
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40. A multi-layer golf ball comprising at least one core layer and at least one cover layer disposed about the at least one core layer, wherein at least one of the golf ball layers about one of the core layers comprises a reaction injection molded material.

41. The golf ball of claim 40, wherein the at least one cover layer comprises an outer cover layer disposed about an inner cover layer.
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42. The golf ball of claim 40, wherein the golf ball comprises a solid or fluid-filled core.
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43. The golf ball of claim 40, which further comprises at least one intermediate layer disposed between the at least one core layer and the at least one cover layer.

44. The golf ball of claim 43, wherein the intermediate layer is a wound layer or comprises a reaction-injection-molded material.
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45. A method for forming golf equipment, or a portion thereof, which comprises:
30 providing a first reactable component comprising an isocyanate-containing compound; and a second reactable component comprising at least one of a polyol, polyamine, or epoxy-containing compound; and
combining the reactable components together to form a reactive mixture; and
injecting the reactive mixture into a cavity or mold having a desired shape
35 within about 60 seconds after the combining to avoid substantial gelation or solidification so as to provide at least a portion of the golf equipment,

wherein the isocyanate-containing compound comprises: a diisocyanate having the generic structure, $\text{O}=\text{C}=\text{N}-\text{R}-\text{N}=\text{C}=\text{O}$, where R is a cyclic, aromatic, or linear branched or unbranched hydrocarbon chain each having a moiety containing from about 1 to 20 carbon atoms; a dimeric or multimeric adduct of a diisocyanate; a triisocyanate or
5 higher functional polyisocyanate that is not an adduct of a diisocyanate; or a mixture thereof.

46. Golf equipment, or a portion thereof, which comprises:
a first reactable component comprising an isocyanate-containing compound;
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a second reactable component comprising at least one of a polyol, polyamine, or epoxy-containing compound,
wherein the golf equipment, or portion thereof, is formed by reaction injection molding of the first and second reactable components, which react with each other
15 after contact sufficiently to be substantially gelled or solidified within about 60 seconds, and wherein the isocyanate-containing compound comprises: a diisocyanate having the generic structure, $\text{O}=\text{C}=\text{N}-\text{R}-\text{N}=\text{C}=\text{O}$, where R is a cyclic, aromatic, or linear branched or unbranched hydrocarbon chain each having a moiety containing from about 1 to 20 carbon atoms; a dimeric or multimeric adduct of a diisocyanate; a triisocyanate or higher functional
20 polyisocyanate that is not an adduct of a diisocyanate; or a mixture thereof.

47. The golf equipment of claim 46, comprising a portion of a multi-layer golf ball.

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